

CLAIMS

What is claimed is:

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A method for visualizing information comprising the steps of:

- a) receiving information having plurality of items;
- b) generating a graph of the items by arranging the items on a spherical surface to specify an initial position of each item;
- c) constructing a frequency matrix for defining a stiffness measure of a spring attached to each pair of items;
- d) relaxing the graph; wherein after relaxation the graph converges to a state of local minimal energy; wherein the distance between a pair of items represents the frequency of the item set in the transaction data; and
- e) employing a directed edge to represent the association confidence levels and association directions between the items in the transaction data.

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2. The method of claim 1 further comprising the steps of:

- f) generating a confidence matrix for defining the confidence level of each association.

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3. The method of claim 2 further comprising the steps of:

- g) receiving a user-defined minimum confidence level;
- h) displaying items having an association with a confidence level that is in a predetermined relationship with the user-defined minimum confidence level.

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4 The method of claim 1 wherein the step of receiving a plurality of items comprises the steps of:

a_1) receiving Internet transaction data; wherein the transaction data is described as follows

5 Transactions {T1, T2, ..., Tn}

Products {P1,...Pm}

Transaction $T_i = \{P_1, \dots, P_{mi}\}$ $i = [1..n]$; and

a_2) extracting items from the Internet transaction data.

10 5. The method of Claim 1 wherein the information includes a plurality of transactions, where each transaction includes one or more items; and wherein the step of generating a graph of the items by arranging the items on a spherical surface to specify an initial position of each item includes the step of

15 b_1) organizing the items based on how frequently the items appear in transactions; and

b_2) specifying the initial position of each item in one of a random fashion and a predetermined fashion.

20 6. The method of Claim 5 wherein the step of specifying the initial position of each item in one of a random fashion and a predetermined fashion includes the step of distributing the items equally on a spherical surface; wherein tightness is a sum of all supports from a current item to directly adjacent items; and wherein more tightly related items are disposed

25 in the center of the sphere and the less tightly related items are evenly distributed around the center.

7. The method of Claim 6 wherein the step of distributing the items equally on a spherical surface includes distributing the items equally on a spherical surface by employing a Poisson Disc Sampling.
8. The method of claim 1 wherein the frequency matrix includes a plurality of elements, wherein each element includes the frequency of occurrence of the association in all transactions after normalization.
9. The method of claim 1 further comprising the step of: transforming stiffness of the spring to a distance in a three-dimensional sphere; wherein the distance between each pair of items represents the support therebetween.
10. The method of claim 1 wherein employing a directed edge to represent the direction of an association between two items further includes the step of: employing color of the edge to indicate confidence level.
11. A system for use in visualizing information comprising:
 - a) a source of transaction data having items; and
 - b) a directed association mechanism coupled to the source of transaction data for receiving transaction data, mapping items and relationships between items to vertices, edges, and positions on a visual spherical surface, and for generating and displaying a self-organized graph, wherein the distance between each pair of items

represents support, a directed edge represents the direction of the association, and the color of the edge is used to represent the confidence level.

12. The system of claim 11 wherein the directed association
mechanism further comprises:

an initialization component for receiving items and arranging the items into an initial position on a spherical surface to generate a graph;

a relaxation component for constructing a frequency matrix that defines a stiffness measure of a spring attached to each pair of items and for relaxing the graph;

wherein after relaxation the graph converges to a state of local minimal energy; and

a direction component for determining edge direction and edge color; wherein the support is the frequency of the item set in the transaction data.

13. The system of claim 12 wherein the relaxation component encapsulates a mass-spring engine for relaxing the graph and enabling the graph to converge to a state of local minimal energy.

14. The system of claim 12 wherein the direction component generates a confidence matrix for defining the direction and confidence level of the association rules.

15. The system of claim 11 wherein the source of transaction data is an electronic commerce web site, the items are products for sale, and the transaction data is transaction data from an electronic commerce application; and

wherein the system is utilized to visually associate product affinities and relationships therebetween.

17. The system of claim 11 wherein the system is utilized in a telecommunications
5 fraud application.

18. The system of claim 11 wherein the system is utilized in a network traffic analysis application.

20. The system of claim 11 wherein the system is utilized in a user profiling application.

20. The system of claim 11 wherein the system is utilized in a user profiling application.

ADD A27

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